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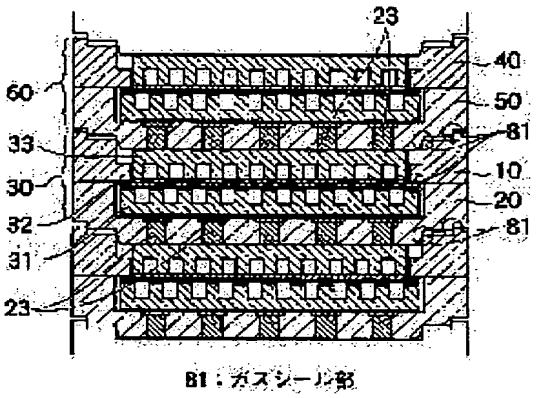
(54) GAS SEPARATOR FOR SOLID ELECTROLYTE TYPE FUEL CELL, MEMBERS THEREOF, AND STACK UNIT USING THE SAME, AND SOLID ELECTROLYTE TYPE FUEL CELL STACK

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a gas separator having an excellent gas sealing characteristic by reducing the contact resistance between members, and provide a stack unit and a SOFC stack.
SOLUTION: This SOFC gas separator formed by laminating multiple flat unit cells 32 is formed of divided two members; an upper member 10 (40) and a lower member 20 (50) connected to the upper member. The upper member has a frame body part 11 (41) having the predetermined thickness and a space part surrounded by the frame body part and for housing the unit cells and the collectors. The lower member has a frame body part 21 (51) having the predetermined thickness, a flat plate part 22 (52) surrounded by the frame body part, an electron flow passage 23 (53) passing through the flat plate part, and a space part formed of the frame body part and the flat plate part and for housing the unit cells and the collectors 31 and 33. this gas separator is used to form the stack unit, and multiple stack plates are laminated to form the SOFC stack.



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CLAIMS

[Claim(s)]
[Claim 1] While forming a gas passageway between [of the solid oxide fuel cell which carried out the laminating of many plate-like single cels / said] single cels In the gas separator of a solid oxide fuel cell which connects said both single cels electrically this gas separator It consists of lower material which was carried out 2 ****s up and down and which was joined to up material and this up material. Said up material It has the space section which holds the charge collector contacted by the electrode layer of the single cel and this single cel which were surrounded in the frame section and this frame section of predetermined thickness. Said lower material The frame section of predetermined thickness, the plate section surrounded by this frame section, and two or more electron flow ways which penetrate this plate section, The gas separator of the solid oxide fuel cell characterized by having the space section which holds the charge collector contacted by the electrode layer of the said single cel and this single cel which are formed in said frame section and plate section.
[Claim 2] LaCrO3 with which the breakthrough to which said electron flow way penetrates the plate section of said lower material was filled up Gas separator of the solid oxide fuel cell according to claim 1 characterized by consisting of the electron flow way material made from the system ceramics and metal felt, or a cermet.
[Claim 3] The member for gas separators which is a top for gas separators according to claim 1 or 2, or lower material, and is characterized by having at least two level difference sections prepared in the frame section top face or the underside by separating predetermined spacing along with the periphery or inner circumference of this frame section.
[Claim 4] The member for gas separators according to claim 3 characterized by having made a part of said a part of frame section top face or level difference section on the top face of the frame section project inside, having prepared the height, having prepared the concave section which ****s in said height in the frame section which counters this height, and preparing the gas-passageway hole which penetrates the frame section or the plate section in said height, the concave section, and/or its contiguity section.
[Claim 5] It is a member for gas separators given in any of claims 1-4 they are, is the really fabricated substantia-compacta sintered compact which uses a magnesia (MgO) and a spinel (MgAl 2O4) as a principal component, or the zygote of a sheet metal-like substantia-compacta sintering plate, and is said MgO and MgAl 2O4. Member for gas separators characterized by mixing ratios being 30 / 70 - 70/30 in a weight ratio.
[Claim 6] Make a part of top face of the frame section project inside, prepare the height, and the concave section which ****s in said height is prepared in the frame section which counters this height. The lower material for gas separators according to claim 4 which prepared the gas-passageway hole which penetrates the frame section or the plate section in the plate section which adjoins said height and this height, Make a part of level difference section on the top face of the frame section project inside, prepare the height, and the concave section which ****s in said height is prepared in the level difference section which counters this height. The up material for gas separators according to claim 4 which prepared the gas-passageway hole which penetrates the frame section in said height and the concave section, The air side charge

collector held in the space section of the lower material for said gas separators, The single cel arranged so that air electrode film may contact this air side charge collector, and said up material for gas separators joined so that a frame section underside might contact the frame section top face of the solid-electrolyte membrane of the top-face periphery section of this single cel, and said lower material, Hold in the space section surrounded in the frame section of this up material for gas separators, and it has the fuel side charge collector arranged so that the fuel electrode film of said single cel may be contacted. The stack unit characterized by making the gas-passageway hole prepared in the concave section of said up material, and the gas-passageway hole prepared in the height of lower material open for free passage.

[Claim 7] Make a part of top face of the frame section project inside, prepare the height, and the concave section which ****s in said height is prepared in the frame section which counters this height. The lower material for gas separators according to claim 4 which prepared the gas-passageway hole which penetrates this frame section or the plate section in the frame section which adjoins this concave section and this concave section, Make a part of level difference section on the top face of the frame section project inside, prepare the height, and the concave section which ****s in said height is prepared in the level difference section which counters this height. The up material for gas separators according to claim 4 which prepared the gas-passageway hole which penetrates the frame section in the frame section which adjoins the frame section and the concave section which adjoin said height, The air side charge collector held in the space section of said lower material for gas separators, The single cel arranged so that air electrode film may contact this air side charge collector, and said up material for gas separators joined so that a frame section underside might contact the frame section top face of the solid-electrolyte membrane of the top-face periphery section of this single cel, and said lower material, Hold in the space section surrounded in the frame section of this up material, and it has the fuel side charge collector arranged so that the fuel electrode film of said single cel may be contacted. The stack unit characterized by making the gas-passageway hole adjoined and prepared in the concave section of a gas-passageway hole and lower material which adjoined the height of said up material and was prepared open for free passage.

[Claim 8] A stack unit and a stack unit according to claim 7 given in above-mentioned claim 6 so that the top face of the fuel side charge collector of a bottom stack unit may be pressed on the plate section underside of the lower material for gas separators of an upside stack unit And at least two level difference sections prepared in the frame section underside of the lower material for gas separators of an upside stack unit fit into at least two level difference sections prepared in the frame section top face of the up material for gas separators of a bottom stack unit, respectively. The solid oxide fuel cell stack which carries out the laminating of a large number by turns so that the gas-seal section may be formed, and is characterized by connecting the single cel of each stack unit to a serial electrically through the electron flow way which penetrates the plate section of said lower material for gas separators.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the stack unit and solid oxide fuel cell stack which used this for the gas separator and its member list of a solid oxide fuel cell, especially, the contact resistance between members is small and excellent in gas-seal nature, and moreover, is strong and relates to the stack unit and solid oxide fuel cell stack which used this for the gas separator and its member list of a solid oxide fuel cell with high dependability and safety.
[0002]
[Description of the Prior Art] A plate-like solid oxide fuel cell carries out the a large number laminating of the single cel which is generally the smallest unit of a cell through the gas separator incorporating a collecting electrode plate, it connects with a serial and/or juxtaposition electrically, and it considers as a fuel cell stack, and contains this fuel cell stack to a box. By there being no leakage of the electrolytic solution, since the reaction rate is large, the solid oxide fuel cell attracts attention as an energy source of low pollution. In a plate-like solid oxide fuel cell (henceforth SOFC), achievement of a gas seal and reduction of electric contact resistance are required simultaneously.
[0003] However, in the conventional SOFC, there was much what incorporated the stack paying attention to achievement of a gas seal or reduction of electric contact resistance, and it was difficult to be compatible in achievement of a gas seal, and reduction of electric contact resistance. That is, although leakage of gas could be prevented in plate-like SOFC by contacting a cel periphery to a gas separator strongly paying attention to a gas seal, there was a problem that contact of the current carrying part which is in a cel center section in this case became sweet, and contact resistance became large by this. On the other hand, when its attention was paid only to reduction of electric contact resistance, the contact pressure of a cel periphery and a gas separator periphery fell, and there was a problem that sufficient gas seal could not be done. Thus, the conventional SOFC(s) were not output characteristics and the thing which fully satisfies all the properties and heat cycle properties over a long period of time.
[0004]
[Problem(s) to be Solved by the Invention] It is excellent in a gas-seal property, is strong, and is to offer the stack unit and solid oxide fuel cell stack which used this for the gas separator of a solid oxide fuel cell with high dependability and safety, and its member list while the technical problem of this invention solves the trouble of the above-mentioned conventional technique, reduces the contact resistance between each part material and prevents rapid degradation of the cell property by the heat cycle.
[0005]
[Means for Solving the Problem] It is important to make a sealing-surface product as narrow as possible, in order to perform certainly the gas seal [in / since the above-mentioned technical problem is solved / by various experiments / in this invention person / SOFC] between members, and the knowledge that it was always necessary to apply a certain amount of planar pressure to a current carrying part in order to improve heat-resistant cycle nature was acquired. And it considers as the core box structure formed by the up material which divided the gas

separator into two up and down, and lower material as a result of inquiring wholeheartedly based on this knowledge. Hold a single cel in the gas separator of this core box structure, and it considers as a stack unit. So that this stack unit may be pressed on the underside of lower material where for example, the electron flow way of an upside unit penetrates the single cel electrode surface or current collection dignity of a bottom unit a laminating and by connecting It finds out that the electric contact resistance between stack units decreases. Again At least two or more level difference sections are prepared in the vertical member top for gas separators which constitutes each stack unit, or the underside periphery section, respectively. A header and this invention were reached [that the gas-seal nature between stack units improves remarkably, etc. and] by carrying out a laminating and forming the gas-seal section so that the level difference section of the underside of an upside unit and the level difference section of the top face of a bottom unit may fit in, respectively.

[0006] That is, the invention which carries out an application for patent by this application is as follows.

(1) While forming a gas passageway between [of the solid oxide fuel cell which carried out the laminating of many plate-like single cels / said] single cels In the gas separator of a solid oxide fuel cell which connects said both single cels electrically this gas separator It consists of lower material which was carried out 2 ****s up and down and which was joined to up material and this up material. Said up material It has the space section which holds the charge collector contacted by the electrode layer of the single cel and this single cel which were surrounded in the frame section and this frame section of predetermined thickness. Said lower material The frame section of predetermined thickness, the plate section surrounded by this frame section, and two or more electron flow ways which penetrate this plate section, The gas separator of the solid oxide fuel cell characterized by having the space section which holds the charge collector contacted by the electrode layer of the said single cel and this single cel which are formed in said frame section and plate section.

[0007] (2) LaCrO3 with which the breakthrough to which said electron flow way penetrates the plate section of said lower material was filled up Gas separator of a solid oxide fuel cell given in the above (1) characterized by consisting of the electron flow way material made from the system ceramics and metal felt, or a cermet.

(3) The member for gas separators which is a top for gas separators the above (1) or given in (2), or lower material, and is characterized by having at least two level difference sections prepared in the frame section top face or the underside by separating predetermined spacing along with the periphery or inner circumference of this frame section.

[0008] (4) The member for gas separators given in the above (3) characterized by having made a part of said a part of frame section top face or level difference section on the top face of the frame section project inside, having prepared the height, having prepared the concave section which ****s in said height in the frame section which counters this height, and preparing the gas-passageway hole which penetrates the frame section or the plate section in said height, the concave section, and/or its contiguity section.

(5) The above (1) It is a member for gas separators given in any of - (4) they are, is the really fabricated substantia-compacta sintered compact which uses a magnesia (MgO) and a spinel (MgAl 2O4) as a principal component, or the zygote of a sheet metal-like substantia-compacta sintering plate, and is said MgO and MgAl 2O4. Member for gas separators characterized by mixing ratios being 30 / 70 - 70/30 in a weight ratio.

[0009] (6) Make a part of top face of the frame section project inside, prepare the height, and prepare the concave section which ****s in said height in the frame section which counters this height. The lower material for gas separators given in the above (4) which prepared the gas-passageway hole which penetrates the frame section or the plate section in the plate section which adjoins said height and this height, Make a part of level difference section on the top face of the frame section project inside, prepare the height, and the concave section which ****s in said height is prepared in the level difference section which counters this height. The up material for gas separators given in the above (4) which prepared the gas-passageway hole which penetrates the frame section in said height and the concave section, The air side charge

collector held in the space section of the lower material for said gas separators, The single cel arranged so that air electrode film may contact this air side charge collector, and said up material for gas separators joined so that a frame section underside might contact the frame section top face of the solid-electrolyte membrane of the top-face periphery section of this single cel, and said lower material, Hold in the space section surrounded in the frame section of this up material for gas separators, and it has the fuel side charge collector arranged so that the fuel electrode film of said single cel may be contacted. The stack unit characterized by making the gas-passageway hole prepared in the concave section of said up material, and the gas-passageway hole prepared in the height of lower material open for free passage.
[0010] (7) Make a part of top face of the frame section project inside, prepare the height, and prepare the concave section which ****s in said height in the frame section which counters this height. The lower material for gas separators given in the above (4) which prepared the gas-passageway hole which penetrates this frame section or the plate section in the frame section which adjoins this concave section and this concave section, Make a part of level difference section on the top face of the frame section project inside, prepare the height, and the concave section which ****s in said height is prepared in the level difference section which counters this height. The up material for gas separators given in the above (4) which prepared the gas-passageway hole which penetrates the frame section in the frame section which adjoins the frame section and the concave section which adjoin said height, The air side charge collector held in the space section of said lower material for gas separators, The single cel arranged so that air electrode film may contact this air side charge collector, and said up material for gas separators joined so that a frame section underside might contact the frame section top face of the solid-electrolyte membrane of the top-face periphery section of this single cel, and said lower material, Hold in the space section surrounded in the frame section of this up material, and it has the fuel side charge collector arranged so that the fuel electrode film of said single cel may be contacted. The stack unit characterized by making the gas-passageway hole adjoined and prepared in the concave section of a gas-passageway hole and lower material which adjoined the height of said up material and was prepared open for free passage.
[0011] (8) A stack unit given in the above (6), and a stack unit given in (7) so that the top face of the fuel side charge collector of a bottom stack unit may be pressed on the plate section underside of the lower material for gas separators of an upside stack unit And at least two level difference sections prepared in the frame section underside of the lower material for gas separators of an upside stack unit fit into at least two level difference sections prepared in the frame section top face of the up material for gas separators of a bottom stack unit, respectively. The solid oxide fuel cell stack which carries out the laminating of a large number by turns so that the gas-seal section may be formed, and is characterized by connecting the single cel of each stack unit to a serial electrically through the electron flow way which penetrates the plate section of said lower material for gas separators.
[0012]
[Embodiment of the Invention] Next, this invention is explained to a detail using a drawing. the explanatory view showing the configuration member of the gas separator (only henceforth a gas separator) of the solid oxide fuel cell drawing 1 and whose drawing 2 are one example of this invention -- it is -- drawing 1 -- a part of up material for gas separators -- a part of lower material for gas separators joined to the up material which showed a notching perspective view and drawing 2 to drawing 1 -- it is a notching perspective view. Moreover, drawing 3 R> 3 and drawing 4 which are mentioned later are the explanatory view showing the stack unit of this invention assembled using the up material for gas separators, and lower material.
[0013] In drawing 1 and drawing 3 , the up material 10 for gas separators of this invention (only henceforth up material) has the space section which holds the charge collector contacted by the electrode layer of the single cel and this single cel which were surrounded in the frame section 11 and this frame section 11 of predetermined thickness. In drawing 2 and drawing 3 moreover, the lower material 20 for gas separators of this invention (only henceforth lower material) The frame section 21 of predetermined thickness, the plate section 22 surrounded by this frame section 21, and two or more electron flow ways 23 which penetrate this plate section 22, In this

example which has the space section which holds the charge collector contacted by the electrode layer of the single cel and this single cel which are formed in said frame section 21 and plate section 22 up material and lower material Two kinds are prepared, respectively and two kinds of stack units are formed using two kinds of up material, and lower material. A gas passageway comes to be connected with a serial by this when the laminating of many stack units is carried out.

[0014] Drawing 3 and drawing 4 are the explanatory views and assembly drawing which were assembled using the up material for gas separators, and lower material and in which showing the 1st stack unit of this invention, and the 2nd stack unit, respectively. In drawing 3 , the up material 10 for gas separators has the two level difference sections 12 and 13 prepared in the top face of the frame section 11 by separating predetermined spacing along with the periphery or inner circumference of this frame section 11. Moreover, this up material 10 has the height 14 which made a part of level difference section 13 project inside, it has the concave section 15 which ****s in said height 14 at the level difference section 13 which counters this height 14, and the gas-passageway holes 16 and 17 which penetrate the frame section 11, respectively are formed in the height 14 and the concave section 15.

[0015] On the other hand, the lower material 20 for gas separators has the height 24 which made a part of top face of the frame section 21 project inside, it has the concave section 25 which ****s in said height 24 at the frame section which counters this height 24, and the gas-passageway holes 27 and 26 which penetrate the frame section or the plate section, respectively are formed in the plate section 22 which adjoins said height 24 and this height 24.

[0016] The 1st stack unit 30 And the lower material 20 for gas separators, The air side charge collector 31 held in the space section of this lower material 20, and the single cel 32 arranged so that air electrode film may contact this air side charge collector 31, The up material 10 for gas separators joined so that an underside might contact the top face of the solid-electrolyte membrane of the top-face periphery section of this single cel 32, and the frame section 21 of said lower material 20, Hold in the space section surrounded in the frame section 11 of this up material 10, and it has the fuel side charge collector 33 arranged so that the fuel electrode film of said single cel 32 may be contacted. It is made to join so that the gas-passageway hole 17 prepared in the concave section 15 of said up material 10 and the gas-passageway hole 27 prepared in the height 24 of the lower material 20 may be open for free passage.

[0017] In drawing 4 , the up material 40 for gas separators has the two level difference sections 42 and 43 prepared in the top face of the frame section 41 by separating predetermined spacing along with the periphery or inner circumference of this frame section 41. Moreover, this up material 40 has the height 44 which made a part of inner circumference side level difference section 43 project inside, has the concave section 45 which ****s in said height 44 at the inner circumference side level difference section 43 which counters this height 44, and has the gas-passageway holes 47 and 46 which penetrate this frame section, respectively in the frame section which adjoins the frame section and the concave section 45 which adjoin the height 44.

[0018] On the other hand, the lower material 50 has the height 54 which made a part of top face of the frame section 51 project inside, it has the concave section 55 which ****s in said height 54 at the frame section which counters this height 54, and the gas-passageway holes 56 and 57 which penetrate the frame section or the plate section, respectively are formed in the frame section 51 which adjoins this concave section 55 and this concave section 55.

[0019] And the 2nd stack unit 60 makes the gas-passageway hole 47 which replaced with the lower material 20 of said 1st stack unit, replaced with the up material 10 using the lower material 50, and was prepared near the height of an assembly and said up material 40 like the 1st stack unit using the up material 40, and the gas-passageway hole 57 prepared near the concave section 55 of the lower material 50 open for free passage, and is a thing.

[0020] The explanatory view in which drawing 5 shows the underside (rear face) of the lower material for gas separators of the 1st stack unit, and drawing 6 are the explanatory views showing the underside (rear face) of the lower material for gas separators of the 2nd stack unit. In drawing 5 , along with the periphery, predetermined spacing is separated in the rear face of the lower material 20 for gas separators, the two level difference sections 28 and 29 are formed

in it, and the height and the concave section are prepared in the level difference section 29 so that it may fit in with the level difference section 43 of the up material 40 of the 2nd stack unit (refer to drawing 4). Moreover, in drawing 6 , along with the periphery, predetermined spacing is separated in the rear face of the lower material 50 for gas separators, the two level difference sections 58 and 59 are formed in it, and the height and the concave section are prepared in the level difference section 59 so that it may fit in with the level difference section 13 of the up material 10 of the 1st stack unit (refer to drawing 3).

[0021] Drawing 7 is the explanatory view of the solid oxide fuel cell stack of this invention which carried out the laminating of two or more stack units. Moreover, drawing 8 is the direction part sectional view of a VIII-VIII line view of drawing 7 . In drawing 7 and 8 the 1st stack unit 30 of drawing 3 and the 2nd stack unit 60 of drawing 4 For example, so that the top face of the fuel side charge collector 33 of a bottom stack unit (1st stack unit 30) may be pressed on the underside of the plate section of the lower material 50 of an upside stack unit (2nd stack unit 60) And the laminating of a large number is carried out by turns so that the two level difference sections prepared in the frame section underside of the lower material 50 of the upside stack unit 60 may fit into the two level difference sections prepared in the frame section top face of the up material 10 of the bottom stack unit 30, respectively and may form the gas-seal section 81. The solid oxide fuel cell stack which connected the single cel 32 of each stack unit to the serial electrically through the electron flow way 23 which penetrates the plate section of the lower material for gas separators is shown.

[0022] One or more of this SOFC stack are connected, it contains to a box, the passage of gas and electric passage are connected, and a solid oxide fuel cell is constituted. Thus, hydrogen gas is supplied to the gas passageway of the constituted solid oxide fuel cell, for example, the single cel 32 upside, air or oxygen gas 72 is supplied to a lower gas passageway as fuel gas 71, electrode reaction arises in each ** cel, electrical energy occurs, and this electrical energy is taken out and used outside.

[0023] According to this example, it considers as the core box structure which divided the gas separator into two up and down. Hold the single cel which contacted the electrode layer in the charge collector in this core box structure, and a stack unit is constituted. By having carried out two or more laminatings and having assembled the SOFC stack so that the plate section which has the electron flow way of the lower material for gas separators of an upside stack unit for this stack unit might be laid on the fuel side charge collector held in the space section of the up material for gas separators of a bottom stack unit The plate section underside of the lower material of said stack unit and a fuel side charge collector come to contact by predetermined planar pressure. Therefore, the electric contact resistance between stack units decreases remarkably. Moreover, gas-seal nature improves more by having prepared the two level difference sections (level difference section of fit structure) in the frame section top face of the up material for gas separators, and the frame section underside of lower material, respectively, having carried out fitting of the up-and-down level difference section, and having formed the long and slender gas-seal section.

[0024] In addition, in the SOFC stack of this example, it generates only in the contact section of the plate section underside of the lower material of an upside stack unit, and the fuel side current collection body surface of a bottom stack unit, but planar pressure can acquire positive electric contact. Moreover, it is desirable to make jointing materials for corrugated fibreboard, such as a glass slurry, placed between the gas-seal sections formed the joint of the up material for gas separators and lower material and between stack units. According to this example, by having contained the single cel and the charge collector and having considered as the stack unit into the box formed by the up material for gas separators, and lower material, the cel itself is exposed, breakage is not received and a mechanical strength improves remarkably.

[0025] In this example, the number of the level difference sections formed in the top face or underside of the up material for gas separators and lower material along with a periphery or inner circumference is at least two. For example, it is narrow in the laminating section between stack units, two steps of opening sections are formed (refer to drawing 8), air is fulfilled by the 1st step of opening section, and the 2nd step of opening section is open for free passage with the

open air in it with this. Therefore, when the two level difference sections of said up material and lower material fit in, respectively, a fuel and air are maintained in separate space and the object of a gas seal can be attained.

[0026] In this invention, a single cel is the minimum configuration unit of a cell, and means the cell which has a plate-like solid-electrolyte membrane, and the fuel lateral electrode film and oxygen lateral electrode film by which the laminating was carried out to both sides of this solid-electrolyte membrane, respectively. As a single cel, the single cel of the substrate supporting lamella mold which carried out the laminating of for example, the sequential fuel lateral electrode film, a solid-electrolyte membrane, and the oxygen lateral electrode film to one side of a charge collector can also be used. A stack unit means one unit of the solid oxide fuel cell stack which held the single cel in the core box structure which consists of up material for gas separators, and lower material. And what is independent, or connected two or more solid oxide fuel cell stacks which carried out the laminating of many stack units, contained to the box, and formed the passage of gas and electric passage is called solid oxide fuel cell.

[0027] In this invention, a gas passageway means the passage which supplies the fuel gas or oxygen gas which is an electrode active material to the electrode layer of the single cel of a solid oxide fuel cell. In this invention, in case the up material for gas separators and lower material carry out the laminating of many stack units which included the single cel in this and a solid oxide fuel cell stack (SOFC stack) is formed, two kinds of things which prepared the gas passageway in a different location are prepared, for example so that each gas passageway may be open for free passage to a serial. And two kinds of stack units are formed using two kinds of up material, and lower material. As long as the up material for gas separators, lower material, and a stack unit are not limited to two kinds and can attain the object of this invention, they may be three kinds or more than it.

[0028] In this invention, from the inside, an electron flow way covers, for example with the disk of the LaCrO3 system perovskite as electron flow way material made from the ceramics, and is formed in the breakthrough for electron flow ways prepared in the lower material for gas separators by being filled up with what calcinated conductive solid-states, such as for example, metal felt or a nickel+YSZ cermet, from the underside side at the pellet type. Although it is desirable in this invention that they are a top view top square or a rectangle as for the up material for a gas separator and these gas separators, and lower material, it is not limited especially.

[0029] As for the up material for gas separators, and lower material, in this invention, it is desirable to consist of a really fabricated substantia-compacta sintered compact which uses the electric insulation matter (MgO), for example, a magnesia, and a spinel (MgAl 2O4) as a principal component, or a zygote of a sheet metal-like substantia-compacta sintering plate. MgO and MgAl 2O4 By using composite material as a principal component, a strong cheap and solid oxide fuel cell is obtained. Moreover, by really considering as the sintered compact of shaping, when a mechanical strength improves more and considers as the zygote of a sheet metal-like substantia-compacta sintering plate, a moldability improves more.

[0030] MgO and MgAl 2O4 a mixing ratio -- a weight ratio -- 30 / 70 - 70/30 -- it is 40 / 60 - 50/50 preferably. This can raise consistency with the coefficient of thermal expansion of YSZ which is the solid electrolyte of the single cel 32. if there are too many mixing ratios of MgO -- coefficient of thermal expansion -- if it becomes excessive and is too few -- coefficient of thermal expansion -- it becomes [too little]. on the other hand -- MgAl 2O4 if there are too many mixing ratios -- coefficient of thermal expansion -- if it becomes [too little] and is too few -- coefficient of thermal expansion -- it becomes excessive. In case the sintered compact which uses a magnesia (MgO) and a spinel (MgAl 2O4) as a principal component is formed, it is desirable as a sintering agent (the 3rd component) to add CaO, and the addition is 0.5 - 1 % of the weight as opposed to the total quantity of said magnesia (MgO) and spinel (MgAl 2O4).

[0031] In this invention, in the frame section top face of the up material for gas separators, and the frame section underside of the lower material for gas separators, predetermined spacing is separated along with the periphery or inner circumference, two or the level difference section beyond it is prepared, and the gas-seal section between stack units is formed by fitting in said

level difference section of the lower material for gas separators of an adjoining stack unit, and up material.

[0032] In this invention, it is desirable to shift only predetermined spacing, without carrying out the right pair of the gate of the fuel gas to the charge collector storage space by the side of a fuel and air, and air content gas. By this, the homogeneity supply nature of the electrode active material to the electrode layer of a single cel can be raised.

[0033]

[Effect of the Invention] According to invention of this application according to claim 1, by having constituted from the up material and lower material which divided the gas separator into two up and down, and having prepared the space section which holds the charge collector contacted by this up material and lower material at the electrode layer of a single cel and this single cel, exposure of a single cel is prevented, it is strong and the high stack unit and solid oxide fuel cell stack of dependability and safety are obtained. According to invention of this application according to claim 2, in addition to the above-mentioned effect of the invention, the electric contact resistance between single cels can be reduced more.

[0034] According to invention of this application according to claim 3, in addition to the above-mentioned effect of the invention, the gas-seal nature between stack units improves. According to invention of this application according to claim 4, in addition to the above-mentioned effect of the invention, a gas passageway can be secured in a stack unit and the gas passageway of each stack unit can be connected with a serial.

[0035] According to invention of this application according to claim 5, the mechanical strength of the vertical member for gas separators can improve, and a coefficient of thermal expansion with YSZ which is the solid-electrolyte membrane of a single cel can be adjusted. According to invention given in claims 6 and 7 of this application, electric contact resistance is small, and is excellent in gas-seal nature, and a stack unit with high dependability and safety is obtained strongly. According to invention of this application according to claim 8, electric contact resistance is small and it excels in gas-seal nature, and moreover it is strong and a solid oxide fuel cell stack with high dependability and safety is obtained.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The up material for gas separators which is one example of this invention is a notching perspective view a part.
[Drawing 2] The lower material for gas separators which is one example of this invention is a notching perspective view a part.
[Drawing 3] The perspective view and assembly drawing showing the 1st stack unit which is one example of this invention.
[Drawing 4] The perspective view and assembly drawing showing the 2nd stack unit which is one example of this invention.
[Drawing 5] The explanatory view showing the underside of the lower material for gas separators of the 1st stack unit which is one example of this invention.
[Drawing 6] The explanatory view showing the underside of the lower material for gas separators of the 2nd stack unit which is one example of this invention.
[Drawing 7] The explanatory view showing the solid oxide fuel cell stack which is one example of this invention.
[Drawing 8] The solid oxide fuel cell stack which is one example of this invention is a sectional view a part.
[Description of Notations]
10 [-- Level difference section,] -- The up material for gas separators, 11 -- The frame section, 12 -- The level difference section, 13 14 [-- Gas-passageway hole,] -- The height, 15 -- The concave section, 16 -- A gas-passageway hole, 17 20 [-- Electron flow way,] -- The lower material for gas separators, 21 -- The frame section, 22 -- The plate section, 23 24 [-- Gas-passageway hole,] -- The height, 25 -- The concave section, 26 -- A gas-passageway hole, 27 28 [-- Air side charge collector,] -- The level difference section, 29 -- The level difference section, 30 -- The 1st stack unit, 31 32 -- A single cel, 33 -- A fuel side charge collector, 40 -- Up material for gas separators, 41 [-- The height, 45 / -- Concave section,] -- The frame section, 42 -- The level difference section, 43 -- The level difference section, 44 46 -- A gas-passageway hole, 47 -- A gas-passageway hole, 50 -- Lower material for gas separators, 51 [-- The height, 55 / -- The concave section, 56 / -- A gas-passageway hole, 57 / -- A gas-passageway hole, 58 / -- The level difference section, 59 / -- The level difference section, 60 / -- The 2nd stack unit, 71 / -- Fuel gas, 72 / -- Air, 81 / -- Gas-seal section.] -- The frame section, 52 -- The plate section, 53 -- An electron flow way, 54

[Translation done.]

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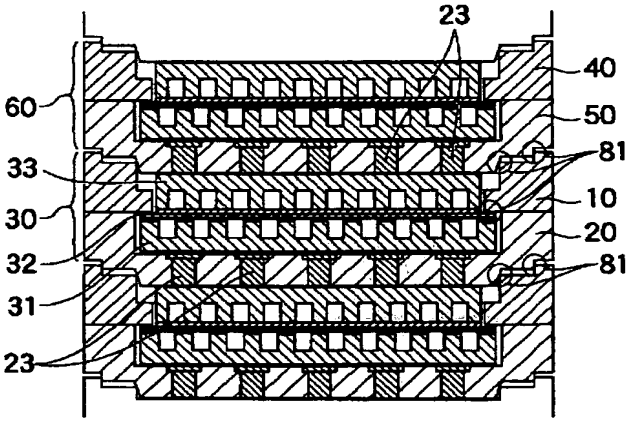
(54)【発明の名称】　固体電解質型燃料電池のガスセパレータおよびその部材並びにこれを用いたスタックユニットおよび固体電解質型燃料電池スタック

(57)【要約】
【課題】　部材相互の接触抵抗を低減し、ガスシール特性に優れたガスセパレータ、スタックユニットおよびＳＯＦＣスタックを提供すること。
【解決手段】　平板状の単セル３２を多数積層したＳＯＦＣのガスセパレータにおいて、このガスセパレータは、上下に２分割された、上部材１０（４０）とこれに接合された下部材２０（５０）とからなり、上部材は、所定厚さの枠体部１１（４１）と、枠体部で囲まれた、単セルおよび集電体を収容する空間部を有し、下部材は、所定厚さの枠体部２１（５１）と、枠体部に囲まれた平板部２２（５２）と、平板部を貫通する電子流路２３（５３）と、枠体部と平板部とで形成される、単セルと集電体３１、３３を収容する空間部とを有し、このガスセパレータを用いてスタックユニットを形成し、スタックユニットを多数積層してＳＯＦＣスタックを形成する。



81：ガスシール部

【特許請求の範囲】

【請求項１】　平板状の単セルを多数積層した固体電解質型燃料電池の前記単セル相互間にガス流路を形成するとともに、前記単セル相互を電気的に接続する固体電解質型燃料電池のガスセパレータにおいて、該ガスセパレータは、上下に２分割された、上部材と該上部材に接合された下部材とからなり、前記上部材は、所定厚さの枠体部と、該枠体部で囲まれた、単セルおよび該単セルの電極膜に当接される集電体を収容する空間部を有し、前記下部材は、所定厚さの枠体部と、該枠体部に囲まれた平板部と、該平板部を貫通する複数の電子流路と、前記枠体部と平板部とで形成される、前記単セルおよび該単セルの電極膜に当接される集電体を収容する空間部とを有することを特徴とする固体電解質型燃料電池のガスセパレータ。

【請求項２】　前記電子流路が、前記下部材の平板部を貫通する貫通孔に充填されたＬａＣｒO_3系セラミックス製電子流路材および金属フェルトまたはサーメットからなることを特徴とする請求項１に記載の固体電解質型燃料電池のガスセパレータ。

【請求項３】　請求項１または２に記載のガスセパレータ用の上または下部材であって、枠体部上面または下面に、該枠体部の外周または内周に沿って所定間隔を隔てて設けられた少なくとも二つの段差部を有することを特徴とするガスセパレータ用の部材。

【請求項４】　前記枠体部上面の一部または枠体部上面の段差部の一部を内側に突出させて凸状部を設け、該凸状部に対向する枠体部に前記凸状部に相応する凹状部を設け、前記凸状部、凹状部および／またはその隣接部に枠体部または平板部を貫通するガス流路孔を設けたことを特徴とする請求項３に記載のガスセパレータ用の部材。

【請求項５】　請求項１～４の何れかに記載のガスセパレータ用の部材であって、マグネシア（ＭｇＯ）とスピネル（$MgAl_2O_4$）を主成分とする、一体成形された緻密質焼結体または薄板状の緻密質焼結板の接合体であって、前記ＭｇＯと$MgAl_2O_4$の混合比が重量比で３０／７０～７０／３０であることを特徴とするガスセパレータ用の部材。

【請求項６】　枠体部の上面の一部を内側に突出させて凸状部を設け、該凸状部に対向する枠体部に前記凸状部に相応する凹状部を設け、前記凸状部および該凸状部に隣接する平板部に枠体部または平板部を貫通するガス流路孔を設けた請求項４に記載のガスセパレータ用の下部材と、枠体部上面の段差部の一部を内側に突出させて凸状部を設け、該凸状部に対向する段差部に前記凸状部に相応する凹状部を設け、前記凸状部および凹状部に枠体部を貫通するガス流路孔を設けた請求項４に記載のガスセパレータ用の上部材と、前記ガスセパレータ用の下部材の空間部に収容された空気側集電体と、該空気側集電体に空気極膜が当接するように配置された単セルと、該単セルの上面外周部の固体電解質膜および前記下部材の枠体部上面に枠体部下面が当接するように接合された、前記ガスセパレータ用上部材と、該ガスセパレータ用上部材の枠体部で囲まれた空間部に収容され、前記単セルの燃料極膜に当接するように配置された燃料側集電体とを有し、前記上部材の凹状部に設けられたガス流路孔と下部材の凸状部に設けられたガス流路孔を連通させたことを特徴とするスタックユニット。

【請求項７】　枠体部の上面の一部を内側に突出させて凸状部を設け、該凸状部に対向する枠体部に前記凸状部に相応する凹状部を設け、該凹状部および該凹状部に隣接する枠体部に該枠体部または平板部を貫通するガス流路孔を設けた請求項４に記載のガスセパレータ用下部材と、枠体部上面の段差部の一部を内側に突出させて凸状部を設け、該凸状部に対向する段差部に前記凸状部に相応する凹状部を設け、前記凸状部に隣接する枠体部および凹状部に隣接する枠体部に、枠体部を貫通するガス流路孔を設けた請求項４に記載のガスセパレータ用上部材と、前記ガスセパレータ用下部材の空間部に収容された空気側集電体と、該空気側集電体に空気極膜が当接するように配置された単セルと、該単セルの上面外周部の固体電解質膜および前記下部材の枠体部上面に枠体部下面が当接するように接合された、前記ガスセパレータ用上部材と、該上部材の枠体部で囲まれた空間部に収容され、前記単セルの燃料極膜に当接するように配置された燃料側集電体とを有し、前記上部材の凸状部に隣接して設けられたガス流路孔と下部材の凹状部に隣接して設けられたガス流路孔を連通させたことを特徴とするスタックユニット。

【請求項８】　上記請求項６に記載のスタックユニットと、請求項７に記載のスタックユニットを、上側スタックユニットのガスセパレータ用下部材の平板部下面で下側スタックユニットの燃料側集電体の上面を押圧するように、かつ上側スタックユニットのガスセパレータ用下部材の枠体部下面に設けられた少なくとも二つの段差部がそれぞれ下側スタックユニットのガスセパレータ用上部材の枠体部上面に設けられた少なくとも二つの段差部に嵌合してガスシール部を形成するように交互に多数積層し、各スタックユニットの単セルを前記ガスセパレータ用下部材の平板部を貫通する電子流路を介して電気的に直列に接続したことを特徴とする固体電解質型燃料電池スタック。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、固体電解質型燃料電池のガスセパレータおよびその部材並びにこれを用いたスタックユニットおよび固体電解質型燃料電池スタックに係り、特に、部材相互の接触抵抗が小さく、ガスシール性に優れ、しかも堅牢で信頼性と安全性の高い固体

電解質型燃料電池のガスセパレータおよびその部材並びにこれを用いたスタックユニットおよび固体電解質型燃料電池スタックに関する。

【０００２】

【従来の技術】平板状固体電解質型燃料電池は、一般に電池の最小単位である単セルを、集電板を組み込んだガスセパレータを介して多数積層し、電気的に直列および／または並列に接続して燃料電池スタックとし、該燃料電池スタックを箱体に収納したものである。固体電解質型燃料電池は、電解液の漏洩がなく反応速度が大きいので、低公害のエネルギー源として注目されている。平板状の固体電解質型燃料電池（以下、ＳＯＦＣともいう）においては、ガスシールの達成と、電気的接触抵抗の低減が同時に要求される。

【０００３】しかしながら、従来のＳＯＦＣではガスシールの達成か、電気的接触抵抗の低減かの何れか一方のみに着目してスタックを組み込んだものが多く、ガスシールの達成と電気的接触抵抗の低減を両立することは困難であった。すなわち、平板状のＳＯＦＣでは、ガスシールに着目してセル周辺部をガスセパレータと強く接触させることによってガスの漏洩を防止できるが、この場合、セル中央部にある導電部の接触が甘くなり、これによって接触抵抗が大きくなるという問題があった。一方、電気的接触抵抗の低減にのみ着目するとセル周辺部とガスセパレータ周辺部との接触面圧が下がり、十分なガスシールができないという問題があった。このように従来のＳＯＦＣは出力特性、長期特性および熱サイクル特性の全てを十分に満足するものではなかった。

【０００４】

【発明が解決しようとする課題】本発明の課題は、上記従来技術の問題点を解決し、各部材相互の接触抵抗を低減して熱サイクルによる電池特性の急速な劣化を防止するとともに、ガスシール特性に優れ、堅牢で、信頼性と安全性の高い、固体電解質型燃料電池のガスセパレータおよびその部材並びにこれを用いたスタックユニットおよび固体電解質型燃料電池スタックを提供することにある。

【０００５】

【課題を解決するための手段】上記課題を解決するため、本発明者は、種々の実験によりＳＯＦＣにおける部材相互のガスシールを確実に行うためにはシール面積をできるだけ狭くすることが重要であり、耐熱サイクル性を改善するためには導電部にある程度の面圧を常にかける必要があるという知見を得た。そして、この知見に基いて鋭意研究した結果、ガスセパレータを上下に２分割した上部材と下部材とで形成される箱型構造とし、該箱型構造のガスセパレータに単セルを収容してスタックユニットとし、このスタックユニットを、下側ユニットの単セル電極面または集電体面を上側ユニットの、例えば電子流路が貫通する下部材の下面で押圧するように積層、接続することにより、スタックユニット相互の電気的接触抵抗が低減することを見出し、また、各スタックユニットを構成するガスセパレータ用の上下部材の上または下面外周部にそれぞれ少なくとも二つ以上の段差部を設け、上側ユニットの下面の段差部と下側ユニットの上面の段差部がそれぞれ嵌合するように積層させてガスシール部を形成することにより、スタックユニット相互間のガスシール性が著しく向上すること等を見出し、本発明に到達した。

【０００６】すなわち、本願で特許請求する発明は、以下のとおりである。

（１）平板状の単セルを多数積層した固体電解質型燃料電池の前記単セル相互間にガス流路を形成するとともに、前記単セル相互を電気的に接続する固体電解質型燃料電池のガスセパレータにおいて、該ガスセパレータは、上下に２分割された、上部材と該上部材に接合された下部材とからなり、前記上部材は、所定厚さの枠体部と、該枠体部で囲まれた、単セルおよび該単セルの電極膜に当接される集電体を収容する空間部を有し、前記下部材は、所定厚さの枠体部と、該枠体部に囲まれた平板部と、該平板部を貫通する複数の電子流路と、前記枠体部と平板部とで形成される、前記単セルおよび該単セルの電極膜に当接される集電体を収容する空間部とを有することを特徴とする固体電解質型燃料電池のガスセパレータ。

【０００７】（２）前記電子流路が、前記下部材の平板部を貫通する貫通孔に充填されたＬａＣｒＯ$_3$系セラミックス製電子流路材および金属フェルトまたはサーメットからなることを特徴とする上記（１）に記載の固体電解質型燃料電池のガスセパレータ。

（３）上記（１）または（２）に記載のガスセパレータ用の上または下部材であって、枠体部上面または下面に、該枠体部の外周または内周に沿って所定間隔を隔てて設けられた少なくとも二つの段差部を有することを特徴とするガスセパレータ用の部材。

【０００８】（４）前記枠体部上面の一部または枠体部上面の段差部の一部を内側に突出させて凸状部を設け、該凸状部に対向する枠体部に前記凸状部に相応する凹状部を設け、前記凸状部、凹状部および／またはその隣接部に枠体部または平板部を貫通するガス流路孔を設けたことを特徴とする上記（３）に記載のガスセパレータ用の部材。

（５）上記（１）～（４）の何れかに記載のガスセパレータ用の部材であって、マグネシア（ＭｇＯ）とスピネル（$MgAl_2O_4$）を主成分とする、一体成形された緻密質焼結体または薄板状の緻密質焼結板の接合体であって、前記ＭｇＯと$MgAl_2O_4$の混合比が重量比で３０／７０～７０／３０であることを特徴とするガスセパレータ用の部材。

【０００９】（６）枠体部の上面の一部を内側に突出さ

せて凸状部を設け、該凸状部に対向する枠体部に前記凸状部に相応する凹状部を設け、前記凸状部および該凸状部に隣接する平板部に枠体部または平板部を貫通するガス流路孔を設けた上記（４）に記載のガスセパレータ用の下部材と、枠体部上面の段差部の一部を内側に突出させて凸状部を設け、該凸状部に対向する段差部に前記凸状部に相応する凹状部を設け、前記凸状部および凹状部に枠体部を貫通するガス流路孔を設けた上記（４）に記載のガスセパレータ用の上部材と、前記ガスセパレータ用の下部材の空間部に収容された空気側集電体と、該空気側集電体に空気極膜が当接するように配置された単セルと、該単セルの上面外周部の固体電解質膜および前記下部材の枠体部上面に枠体部下面が当接するように接合された、前記ガスセパレータ用上部材と、該ガスセパレータ用上部材の枠体部で囲まれた空間部に収容され、前記単セルの燃料極膜に当接するように配置された燃料側集電体とを有し、前記上部材の凹状部に設けられたガス流路孔と下部材の凸状部に設けられたガス流路孔を連通させたことを特徴とするスタックユニット。

【００１０】（７）枠体部の上面の一部を内側に突出させて凸状部を設け、該凸状部に対向する枠体部に前記凸状部に相応する凹状部を設け、該凹状部および該凹状部に隣接する枠体部に該枠体部または平板部を貫通するガス流路孔を設けた上記（４）に記載のガスセパレータ用下部材と、枠体部上面の段差部の一部を内側に突出させて凸状部を設け、該凸状部に対向する段差部に前記凸状部に相応する凹状部を設け、前記凸状部に隣接する枠体部および凹状部に隣接する枠体部に、枠体部を貫通するガス流路孔を設けた上記（４）に記載のガスセパレータ用上部材と、前記ガスセパレータ用下部材の空間部に収容された空気側集電体と、該空気側集電体に空気極膜が当接するように配置された単セルと、該単セルの上面外周部の固体電解質膜および前記下部材の枠体部上面に枠体部下面が当接するように接合された、前記ガスセパレータ用上部材と、該上部材の枠体部で囲まれた空間部に収容され、前記単セルの燃料極膜に当接するように配置された燃料側集電体とを有し、前記上部材の凸状部に隣接して設けられたガス流路孔と下部材の凹状部に隣接して設けられたガス流路孔を連通させたことを特徴とするスタックユニット。

【００１１】（８）上記（６）に記載のスタックユニットと、（７）に記載のスタックユニットを、上側スタックユニットのガスセパレータ用下部材の平板部下面で下側スタックユニットの燃料側集電体の上面を押圧するように、かつ上側スタックユニットのガスセパレータ用下部材の枠体部下面に設けられた少なくとも二つの段差部がそれぞれ下側スタックユニットのガスセパレータ用上部材の枠体部上面に設けられた少なくとも二つの段差部に嵌合してガスシール部を形成するように交互に多数積層し、各スタックユニットの単セルを前記ガスセパレータ用下部材の平板部を貫通する電子流路を介して電気的に直列に接続したことを特徴とする固体電解質型燃料電池スタック。

【００１２】

【発明の実施の形態】次に、本発明を図面を用いて詳細に説明する。図１および図２は、本発明の一実施例である固体電解質型燃料電池のガスセパレータ（以下、単にガスセパレータという）の構成部材を示す説明図であり、図１はガスセパレータ用上部材の一部切欠斜視図、図２は、図１に示した上部材に接合されるガスセパレータ用下部材の一部切欠斜視図である。また、後述する図３および図４は、ガスセパレータ用上部材および下部材を用いて組み立てた本発明のスタックユニットを示す説明図である。

【００１３】図１および図３において、本発明のガスセパレータ用上部材（以下、単に上部材ともいう）１０は、所定厚さの枠体部１１と、該枠体部１１で囲まれた、単セルおよび該単セルの電極膜に当接される集電体を収容する空間部を有する。また図２および図３において、本発明のガスセパレータ用下部材（以下、単に下部材ともいう）２０は、所定厚さの枠体部２１と、該枠体部２１に囲まれた平板部２２と、該平板部２２を貫通する複数の電子流路２３と、前記枠体部２１と平板部２２とで形成される、単セルおよび該単セルの電極膜に当接される集電体を収容する空間部を有する本実施例において、上部材および下部材は、それぞれ２種類用意され、２種類の上部材および下部材を用いて２種類のスタックユニットが形成される。これによって、スタックユニットを多数積層した際、ガス流路が直列に連結されるようになる。

【００１４】図３および図４は、ガスセパレータ用上部材および下部材を用いて組み立てた、それぞれ本発明の第１のスタックユニットおよび第２のスタックユニットを示す説明図および組立図である。図３において、ガスセパレータ用上部材１０は、枠体部１１の上面に、該枠体部１１の外周または内周に沿って所定間隔を隔てて設けられた二つの段差部１２、１３を有する。また、この上部材１０は、段差部１３の一部を内側に突出させた凸状部１４を有し、該凸状部１４に対向する段差部１３に前記凸状部１４に相応する凹状部１５を有し、凸状部１４および凹状部１５にはそれぞれ枠体部１１を貫通するガス流路孔１６および１７が設けられている。

【００１５】一方、ガスセパレータ用下部材２０は、枠体部２１の上面の一部を内側に突出させた凸状部２４を有し、該凸状部２４に対向する枠体部に前記凸状部２４に相応する凹状部２５を有し、前記凸状部２４および該凸状部２４に隣接する平板部２２にそれぞれ枠体部または平板部を貫通するガス流路孔２７および２６が設けられている。

【００１６】そして第１のスタックユニット３０は、ガ

スセパレータ用下部材２０と、該下部材２０の空間部に収容された空気側集電体３１と、該空気側集電体３１に空気極膜が当接するように配置された単セル３２と、該単セル３２の上面外周部の固体電解質膜および前記下部材２０の枠体部２１の上面に下面が当接するように接合されたガスセパレータ用上部材１０と、該上部材１０の枠体部１１で囲まれた空間部に収容され、前記単セル３２の燃料極膜に当接するように配置された燃料側集電体３３とを有し、前記上部材１０の凹状部１５に設けられたガス流路孔１７と下部材２０の凸状部２４に設けられたガス流路孔２７が連通するように接合させたものである。

【００１７】図４において、ガスセパレータ用上部材４０は、枠体部４１の上面に、該枠体部４１の外周または内周に沿って所定間隔を隔てて設けられた二つの段差部４２、４３を有する。また、この上部材４０は、内周側段差部４３の一部を内側に突出させた凸状部４４を有し、該凸状部４４に対向する内周側段差部４３に前記凸状部４４に相応する凹状部４５を有し、凸状部４４に隣接する枠体部および凹状部４５に隣接する枠体部にそれぞれ該枠体部を貫通するガス流路孔４７および４６を有している。

【００１８】一方、下部材５０は、枠体部５１の上面の一部を内側に突出させた凸状部５４を有し、該凸状部５４に対向する枠体部に前記凸状部５４に相応する凹状部５５を有し、該凹状部５５および該凹状部５５に隣接する枠体部５１にそれぞれ枠体部または平板部を貫通するガス流路孔５６および５７が設けられている。

【００１９】そして第２のスタックユニット６０は、前記第１のスタックユニットの下部材２０に代えて下部材５０を用い、上部材１０に代えて上部材４０を用いて第１のスタックユニットと同様に組立て、前記上部材４０の凸状部の近傍に設けたガス流路孔４７と下部材５０の凹状部５５の近傍に設けたガス流路孔５７を連通させものである。

【００２０】図５は、第１スタックユニットのガスセパレータ用下部材の下面（裏面）を示す説明図、図６は、第２スタックユニットのガスセパレータ用下部材の下面（裏面）を示す説明図である。図５において、ガスセパレータ用下部材２０の裏面には、その外周に沿って所定間隔を隔てて二つの段差部２８および２９が形成されており、段差部２９には、第２スタックユニット（図４参照）の上部材４０の段差部４３と嵌合するように凸状部および凹状部が設けられている。また、図６において、ガスセパレータ用下部材５０の裏面には、その外周に沿って所定間隔を隔てて二つの段差部５８および５９が形成されており、段差部５９には、第１スタックユニット（図３参照）の上部材１０の段差部１３と嵌合するように凸状部および凹状部が設けられている。

【００２１】図７は、複数のスタックユニットを積層した本発明の固体電解質型燃料電池スタックの説明図である。また図８は、図７のVIII－VIII線矢視方向一部断面図である。図７および８において、図３の第１スタックユニット３０と図４の第２スタックユニット６０が、例えば上側スタックユニット（第２のスタックユニット６０）の下部材５０の平板部の下面で下側スタックユニット（第１のスタックユニット３０）の燃料側集電体３３の上面を押圧するように、かつ上側スタックユニット６０の下部材５０の枠体部下面に設けられた二つの段差部がそれぞれ下側スタックユニット３０の上部材１０の枠体部上面に設けられた二つの段差部に嵌合してガスシール部８１を形成するように交互に多数積層し、各スタックユニットの単セル３２をガスセパレータ用下部材の平板部を貫通する電子流路２３を介して電気的に直列に接続した固体電解質型燃料電池スタックが示されている。

【００２２】このＳＯＦＣスタックの一つまたは複数個を接続して箱体に収納し、ガスの流路および電気の流路を連結して固体電解質型燃料電池が構成される。このようにして構成された固体電解質型燃料電池の、例えば単セル３２の上側のガス流路に燃料ガス７１として例えば水素ガスが、下側のガス流路に空気または酸素ガス７２が供給され、各単セルで電極反応が生じて電気エネルギが発生し、この電気エネルギが外部に取り出されて利用される。

【００２３】本実施例によれば、ガスセパレータを上下に２分割した箱型構造とし、この箱型構造内に電極膜に集電体を当接した単セルを収容してスタックユニットを構成し、該スタックユニットを、上側スタックユニットのガスセパレータ用下部材の電子流路を有する平板部を下側スタックユニットのガスセパレータ用上部材の空間部に収容された燃料側集電体上に載置するように複数積層してＳＯＦＣスタックを組み立てたことにより、前記スタックユニットの下部材の平板部下面と燃料側集電体とが所定の面圧で接触するようになる。従って、スタックユニット相互の電気的接触抵抗が著しく低減する。また、ガスセパレータ用上部材の枠体部上面および下部材の枠体部下面にそれぞれ二つの段差部（ハメアイ構造の段差部）を設け、上下の段差部を嵌合させて細長いガスシール部を形成したことにより、ガスシール性がより向上する。

【００２４】なお、本実施例のＳＯＦＣスタックにおいて、面圧は上側スタックユニットの下部材の平板部下面と下側スタックユニットの燃料側集電体表面との当接部にしか発生せず、確実な電気的接触を得ることができる。また、ガスセパレータ用上部材と下部材との接合部およびスタックユニット相互間に形成されるガスシール部にはガラススラリー等の接合材を介在させることが好ましい。本実施例によれば、ガスセパレータ用上部材と下部材とで形成される箱体内に単セルおよび集電体を収納してスタックユニットとしたことにより、セル自身が

露出して損傷を受けることがなく機械的強度が著しく向上する。

【００２５】本実施例において、ガスセパレータ用の上部材および下部材の上面または下面に外周または内周に沿って形成される段差部は、少なくとも二つである。これによって、スタックユニット相互の積層部には狭い、例えば２段の空隙部が形成され（図８参照）、１段目の空隙部には空気が満たされ、２段目の空隙部は外気と連通する。従って前記上部材と下部材の二つの段差部がそれぞれ嵌合することによって燃料と空気が別々の空間に維持され、ガスシールの目的を達成することができる。

【００２６】本発明において単セルとは、電池の最小構成単位であって、平板状の固体電解質膜と、該固体電解質膜の両面にそれぞれ積層された燃料側電極膜および酸素側電極膜とを有する電池をいう。単セルとして、集電体の片面に、例えば順次燃料側電極膜、固体電解質膜および酸素側電極膜を積層した基板支持膜型の単セルを用いることもできる。スタックユニットとは、ガスセパレータ用上部材と下部材で構成される箱型構造体に単セルを収容した、固体電解質型燃料電池スタックの一単位をいう。そしてスタックユニットを多数積層した固体電解質型燃料電池スタックを単独で、または複数接続して箱体に収納してガスの流路および電気の流路を形成したものを固体電解質型燃料電池という。

【００２７】本発明においてガス流路とは、固体電解質型燃料電池の単セルの電極膜に電極活物質である燃料ガスまたは酸素ガスを供給する流路をいう。本発明において、ガスセパレータ用上部材および下部材は、これに単セルを組み込んだスタックユニットを多数積層して固体電解質型燃料電池スタック（ＳＯＦＣスタック）を形成する際、各ガス流路が直列に連通するように、異なる位置にガス流路を設けたものが、例えば２種類用意される。そして２種類の上部材および下部材を用いて２種類のスタックユニットが形成される。ガスセパレータ用上部材、下部材およびスタックユニットは２種類に限定されるものではなく、本発明の目的を達成できれば３種類またはそれ以上であってもよい。

【００２８】本発明において電子流路は、ガスセパレータ用下部材に設けられた電子流路用の貫通孔に、内側から、例えばセラミックス製電子流路材としてのＬａＣｒO_3系ペロブスカイトの円板で蓋をし、下面側から金属フェルトまたは、例えばＮｉ＋ＹＳＺサーメット等の導電性固体をペレット状に焼成したものを充填することによって形成される。本発明においてガスセパレータならびに該ガスセパレータ用上部材および下部材は、平面図上正方形または長方形であることが好ましいが、特に限定されるものではない。

【００２９】本発明において、ガスセパレータ用上部材および下部材は、電気絶縁性物質、例えばマグネシア（ＭｇＯ）とスピネル（$MgAl_2O_4$）を主成分とする、一体成形された緻密質焼結体または薄板状の緻密質焼結板の接合体からなることが好ましい。ＭｇＯと$MgAl_2O_4$の複合材料を主成分とすることにより、安価にかつ堅牢な固体電解質型燃料電池が得られる。また、一体成形の焼結体とすることにより、機械的強度がより向上し、薄板状の緻密質焼結板の接合体とすることにより、成形性がより向上する。

【００３０】ＭｇＯと$MgAl_2O_4$との混合比は重量比で３０／７０～７０／３０、好ましくは４０／６０～５０／５０である。これによって、単セル３２の固体電解質であるＹＳＺの熱膨張係数との整合性を高めることができる。ＭｇＯの混合比が多すぎると熱膨張率過大となり、少なすぎると熱膨張率過小となる。一方、$MgAl_2O_4$の混合比が多すぎると熱膨張率過小となり、少なすぎると熱膨張率過大となる。マグネシア（ＭｇＯ）とスピネル（$MgAl_2O_4$）を主成分とする焼結体を形成する際、焼結剤（第３成分）として、例えばＣａＯを添加することが好ましく、その添加量は、前記マグネシア（ＭｇＯ）とスピネル（$MgAl_2O_4$）の合計量に対して、例えば０．５～１重量％である。

【００３１】本発明において、ガスセパレータ用上部材の枠体部上面およびガスセパレータ用下部材の枠体部下面にはその外周または内周に沿って所定間隔を隔てて二つまたはそれ以上の段差部が設けられており、隣接するスタックユニットのガスセパレータ用下部材および上部材の前記段差部を嵌合することによりスタックユニット相互間のガスシール部が形成される。

【００３２】本発明において、燃料側および空気側の集電体収納スペースへの燃料ガスおよび空気含有ガスの出入口を正対させることなく、所定間隔だけずらすことが好ましい。これによって、単セルの電極膜への電極活物質の均一供給性を向上させることができる。

【００３３】

【発明の効果】本願の請求項１に記載の発明によれば、ガスセパレータを上下に２分割した上部材と下部材とで構成し、該上部材と下部材に、単セルおよび該単セルの電極膜に当接される集電体を収容する空間部を設けたことにより、単セルの露出を防止し、堅牢で信頼性と安全性の高いスタックユニットおよび固体電解質型燃料電池スタックが得られる。本願の請求項２に記載の発明によれば、上記発明の効果に加え、単セル相互間の電気的接触抵抗をより低減することができる。

【００３４】本願の請求項３に記載の発明によれば、上記発明の効果に加え、スタックユニット相互間のガスシール性が向上する。本願の請求項４に記載の発明によれば、上記発明の効果に加え、スタックユニット内にガス流路を確保し、各スタックユニットのガス流路を直列に連結することができる。

【００３５】本願の請求項５に記載の発明によれば、ガスセパレータ用の上下部材の機械的強度が向上し、かつ

単セルの固体電解質膜である、例えばＹＳＺとの熱膨張係数を整合させることができる。本願の請求項６および７に記載の発明によれば、電気的接触抵抗が小さく、ガスシール性に優れ、堅牢で、かつ信頼性と安全性の高いスタックユニットが得られる。本願の請求項８に記載の発明によれば、電気的接触抵抗が小さく、ガスシール性に優れ、そのうえ堅牢で、信頼性と安全性の高い固体電解質型燃料電池スタックが得られる。

【図面の簡単な説明】

【図１】本発明の一実施例であるガスセパレータ用上部材の一部切欠斜視図。

【図２】本発明の一実施例であるガスセパレータ用下部材の一部切欠斜視図。

【図３】本発明の一実施例である第１スタックユニットを示す斜視図および組立図。

【図４】本発明の一実施例である第２スタックユニットを示す斜視図および組立図。

【図５】本発明の一実施例である第１スタックユニットのガスセパレータ用下部材の下面を示す説明図。

【図６】本発明の一実施例である第２スタックユニットのガスセパレータ用下部材の下面を示す説明図。

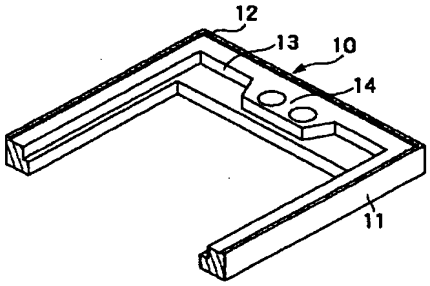
【図７】本発明の一実施例である固体電解質型燃料電池スタックを示す説明図。

【図８】本発明の一実施例である固体電解質型燃料電池スタックの一部断面図。

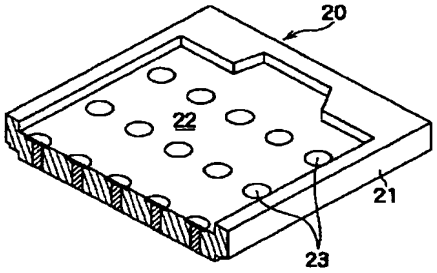
【符号の説明】

１０…ガスセパレータ用上部材、１１…枠体部、１２…段差部、１３…段差部、１４…凸状部、１５…凹状部、１６…ガス流路孔、１７…ガス流路孔、２０…ガスセパレータ用下部材、２１…枠体部、２２…平板部、２３…電子流路、２４…凸状部、２５…凹状部、２６…ガス流路孔、２７…ガス流路孔、２８…段差部、２９…段差部、３０…第１スタックユニット、３１…空気側集電体、３２…単セル、３３…燃料側集電体、４０…ガスセパレータ用上部材、４１…枠体部、４２…段差部、４３…段差部、４４…凸状部、４５…凹状部、４６…ガス流路孔、４７…ガス流路孔、５０…ガスセパレータ用下部材、５１…枠体部、５２…平板部、５３…電子流路、５４…凸状部、５５…凹状部、５６…ガス流路孔、５７…ガス流路孔、５８…段差部、５９…段差部、６０…第２スタックユニット、７１…燃料ガス、７２…空気、８１…ガスシール部。

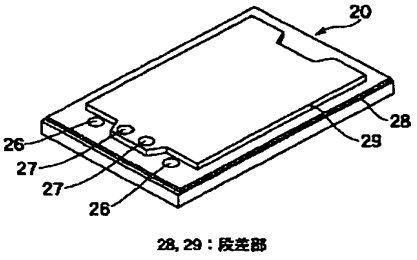
【図１】



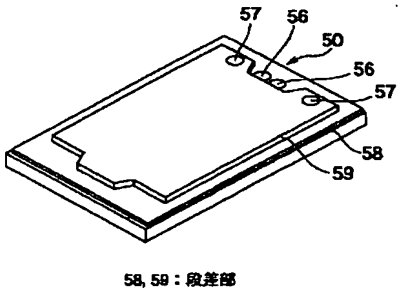
【図２】



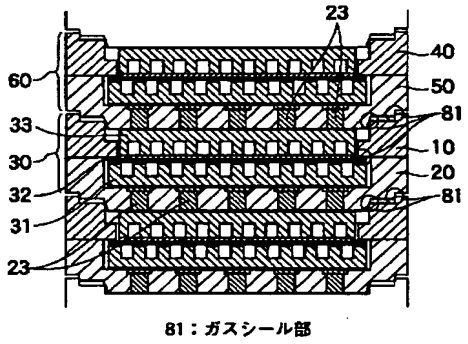
【図５】



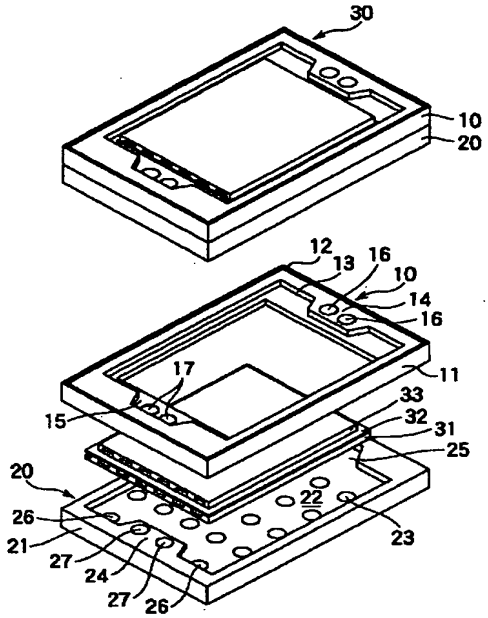
【図６】



【図８】

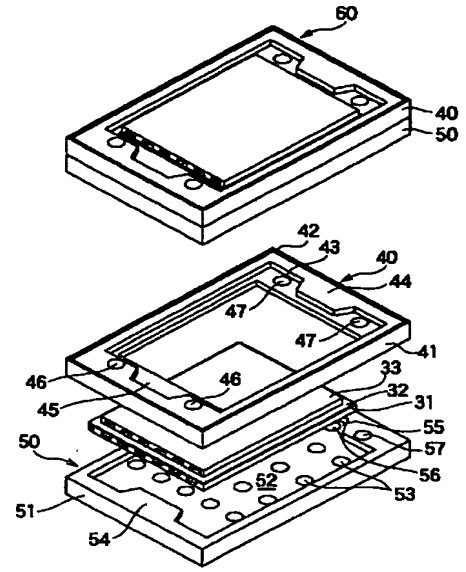


【図３】



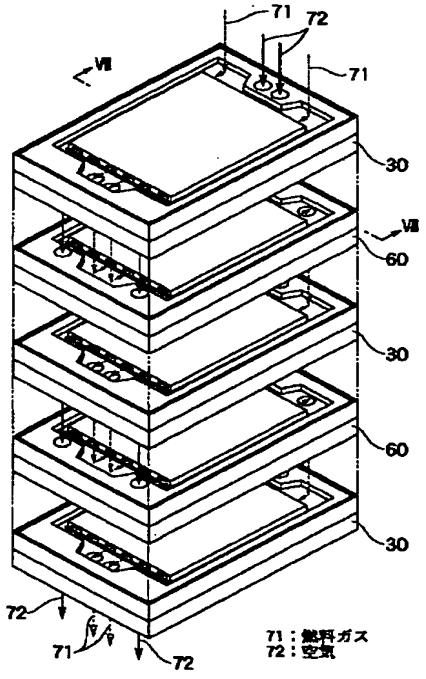
15：凹状部
16, 17：ガス流路
24：凸状部
25：凹状部
26, 27：ガス流路
30：第1スタックユニット
31：空気側集電体
32：単セル
33：燃料側集電体

【図４】



40：ガスセパレータ用上部材
41：枠体部
42, 43：段差部
44：凸状部
45：凹状部
46, 47：ガス流路
50：ガスセパレータ用下部材
51：枠体部
52：平板部
53：電子流路
54：凸状部
55：凹状部
56, 57：ガス流路
60：第2スタックユニット

【図７】



71：燃料ガス
72：空気

フロントページの続き

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